

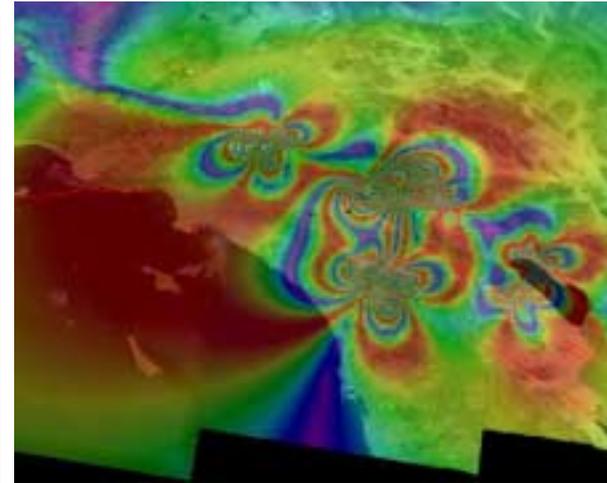


Visualization for Earth Science Datasets

PI: Peggy Li, JPL

Objective

- Extend the functionalities of RIVA (Remote Interactive Visualization and Analysis System) and ParVox (PARallel VOXel Renderer) [both developed at JPL] to enable the visualization of solid earth system datasets.
- Use RIVA to produce movies of displacement data generated from selected 3D simulation tools at 1km resolution for Southern California.
- Use ParVox as an interactive vis. tool to display 3D structure, stain and other physical properties of earthquake simulation data sets.



Surface Deformation Caused by simulated earthquakes - data from Virtual California

Approach

- Enhance the core renderer, the graphical user interface, the keyframe editor and the input file format of RIVA to support time-varying datasets.
- Enhance the unstructured grid volume renderer in ParVox to support perspective rendering and viewing inside the volume.

Key Milestones

- Complete RIVA functionalities to support multi-variable, time-varying datasets 9/02
- Integrate RIVA into the QuakeSim Framework and produce animations of surface displacement using data generated by Virtual California and GeoFEST. 2/03
- Extend ParVox to support unstructured grid time-varying volumes. 9/03
- Demonstrate interactive visualization of 3D structures of earthquake datasets through the grid framework. 2/04
- Deliver ParVox source code via OpenChannel Foundation 9/04

Partners: A.Donnellan/JPL, J.Rundle/UC Davis, M.Pierce/Indiana U

TRL_{in} =4



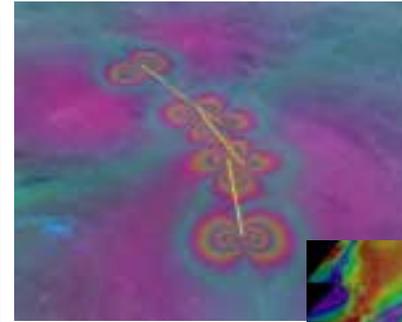
Visualization for Earth Science Datasets

PI: Dr P. Peggy Li at Jet Propulsion Laboratory

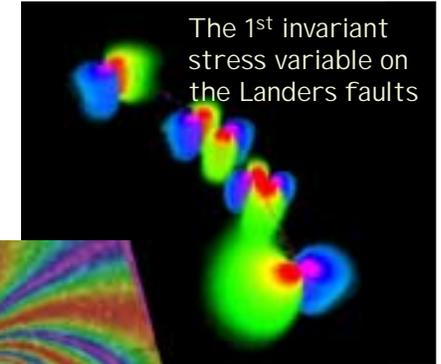
Objective

Enhance the functionalities of RIVA (Remote Interactive Visualization and Analysis System) and ParVox (PARallel VOXel Renderer) for the visualization of the solid earth system datasets.

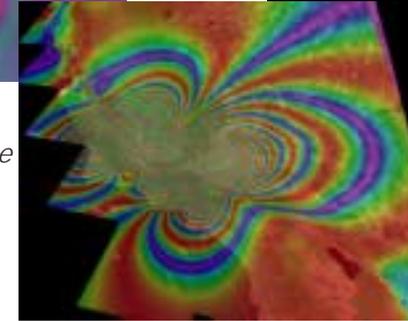
- Use RIVA to produce movies of the surface displacement generated from selected 3D simulation tools at 1km resolution for Southern California.
- Use ParVox as an interactive visualization tool to display 3D structure, stress and other physical properties of earthquake simulation data sets.



Surface deformation interferogram from the Landers Earthquake



The 1st invariant stress variable on the Landers faults



A simulated earthquake on San Andreas fault

Accomplishments

- Produced 1000 year post-seismic surface deformation animations for the GeoFEST Northridge and Landers models using RIVA.
- Produced a 500 year California simulated earthquake animations generated by the Virtual California Model using RIVA.
- Produced a 3D stress invariants animation for the GeoFEST Landers model using ParVox.
- Integrated RIVA into the QuakeSim portal to produce animations for the GeoFEST model outputs.
- Integrated ParVox into the QuakeSim portal as an interactive visualization tool for the 3D GeoFEST stress data.
- Demonstrated an end-to-end modeling and visualization system for the earthquake simulation using the QuakeSim portal at I GARSS'04 in Anchorage, Alaska. Configured and ran GeoFEST, RIVA, and ParVox on three geographically distributed computers through the portal in real time.
- Released RIVA and ParVox source code to the general public via OpenChannel.

TRL_{in} = 4; TRL_{out} = 6

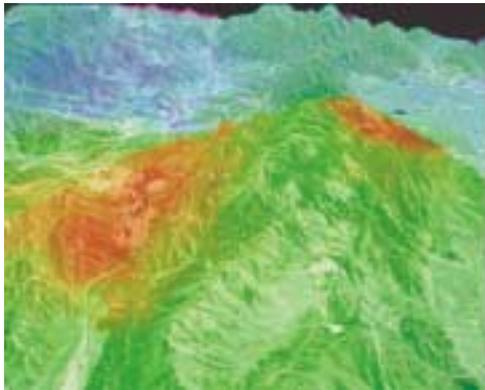




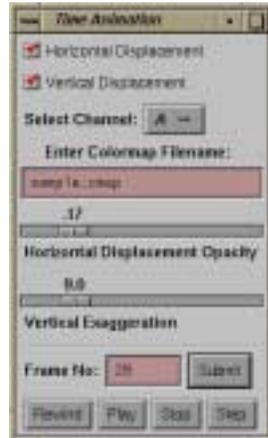
Visualization for Earth Science Datasets

PI: Dr P. Peggy Li, JPL

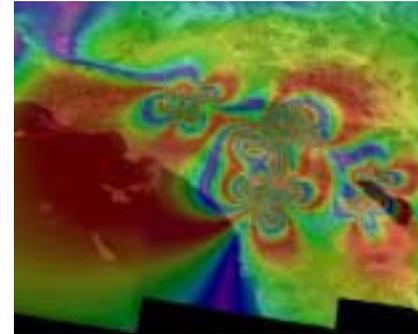
Examples of the Tools' Capabilities



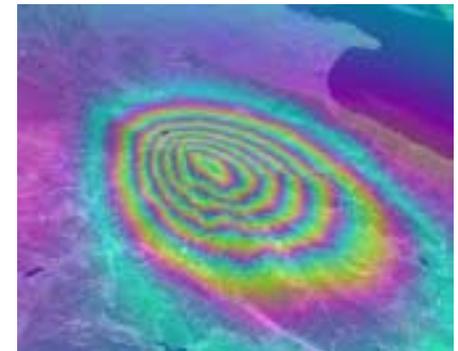
The Northridge Earthquake Surface Displacement



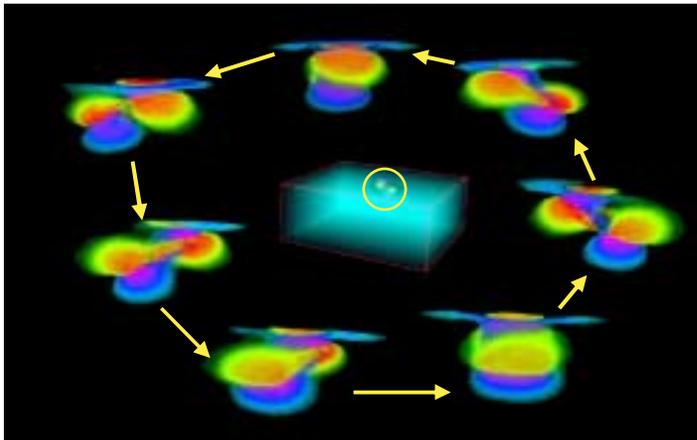
Time Animation Control in RIVA



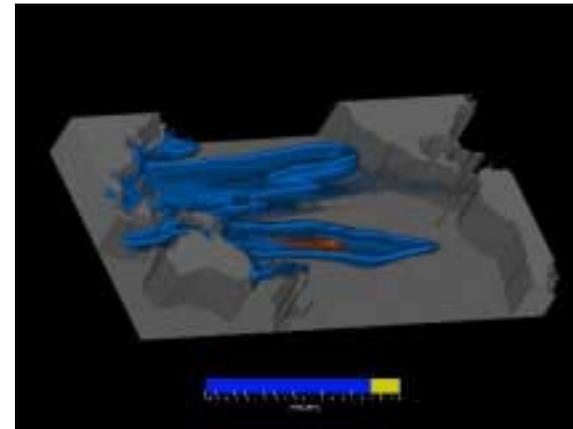
A snapshot from the Virtual California movie showing surface deformation caused by several earthquakes



A snapshot from the GeoFEST movie. Each color fringe represents 5.6 cm vertical deformation.



A 360° view of the mean stress value of the Northridge fault



A snapshot from the tracer evolution animation

The simulation shows that the intra-seasonal variability alters the pathway by stirring the water masses.

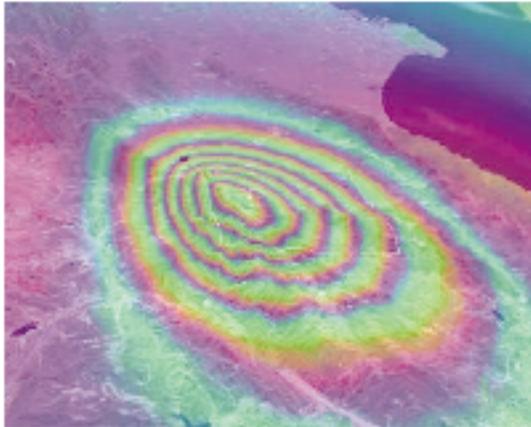
<http://pat.jpl.nasa.gov/public/RIVA>



Visualization for Earth Science Datasets

PI: Dr P. Peggy Li, JPL

Application of RIVA to Movies of Earthquake Model Output

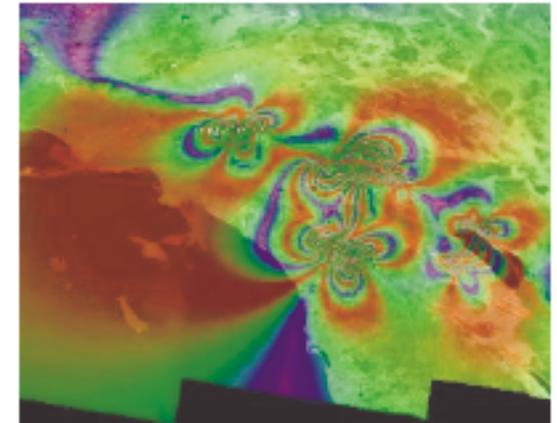


Postseismic surface deformation after Northridge Earthquake:

This movie shows 500 years of simulation results generated by **GeoFEST**, a 3D finite element software package modeling solid stress and strain. The data was provided by Dr. Jay Parker of JPL. Simulation data is superimposed on a LandSAT image of Southern California with the Northridge fault drawn as a yellow rectangle. The movie starts with a fly-around of the Northridge fault, followed by the deformation that resulted from the earthquake. After the initial deformation fades out, it animates the accumulated surface deformation for 500 years. Each color fringe in the movie represents 5.6 cm vertical displacement.

1000 Years Surface Deformation Simulated by Virtual California:

This movie shows 1000 years of simulation results generated by **Virtual California**, a Monte Carlo code that generates simulated earthquakes on arbitrary fault surface mesh. The data were provided by Professor John Rundle, University of California, Davis. The fault data base used by the simulation is drawn as red lines on top of the LandSAT image. The animation shows 5 days moving windows of horizontal surface deformation. The color fringe simulates InSAR L band, i.e., 23 cm per fringe.



Movies available at <http://pat.jpl.nasa.gov/public/RIVA/images.html>



Visualization for Earth Science Datasets

PI : Dr P. Peggy Li, JPL



RIVA (Remote Interactive Visualization and Analysis) System is a parallel and distributed terrain rendering system for large earth and planetary terrain images. It can be used as interactive visualization tool, a key frame editing tool for animation, and a batch processing rendering engine.

RIVA has been enhanced to visualize time-sequence simulation and modeling data, such as surface deformation generated by earthquake simulation models.

- RIVA version 1.0 released on Open Channel Foundation (OCF)
<http://www.openchannelsoftware.com/projects/RIVA>
- RIVA online documentation available in <http://pat.jpl.nasa.gov/RIVA>
- Seven RIVA animations available in both RIVA websites
- OCF supports hosting of application software as well as resources to promote commercialization of popular programs
- Users request software and must sign a license agreement before the tool is delivered

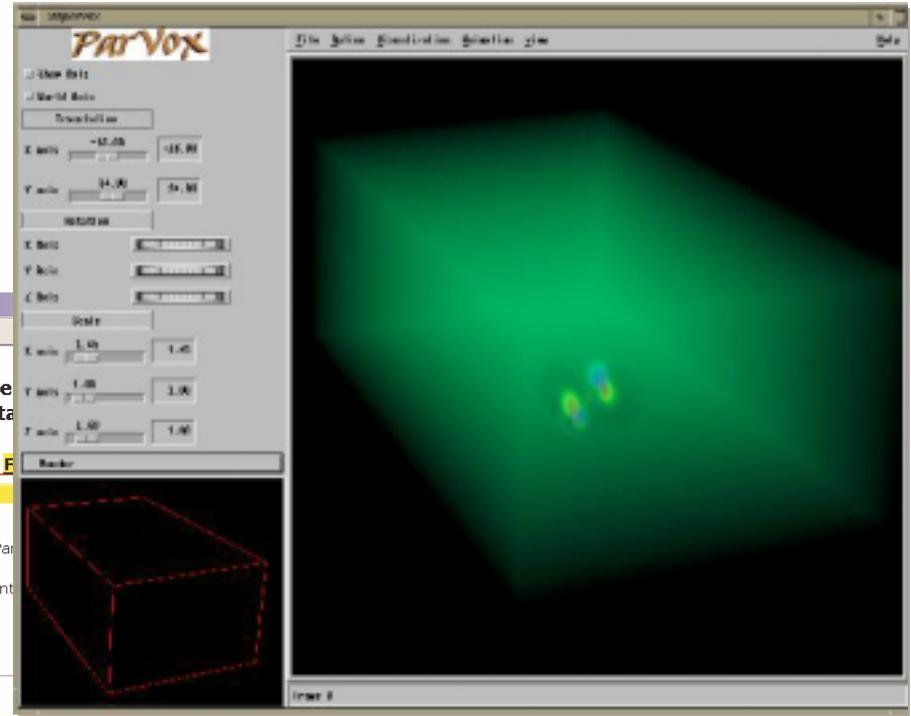




Visualization for Earth Science Datasets

PI: Dr P. Peggy Li, JPL

From the QuakeSIM Portal to ParVox



a Web Service (<http://complexity.ucs.indiana.edu:8282>) in the QuakeSIM portal runs a GeoFEST-ParVox task remotely on an SGI Altix at JPL

Visualization of the 1st and 2nd invariants of the stress tensor variables from the GeoFEST simulation.
http://pat.jpl.nasa.gov/ParVox/animations/landers_parvox_new.mpg

